SENSE AND DESTROY ARMOR (SADARM)

Army ACAT IC Program		**Prime Contractor**
Total Number of Rounds:	47,331	GENCORP Inc. (Aerojet)
Total Program Cost (TY$):	$3075.8M	
Average Unit Cost (TY$):	$65,000	
Full-rate production:	FY05	

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

SADARM is a "smart" artillery submunition designed for ***precision engagement*** of self-propelled howitzers and other lightly armored vehicles. By destroying the enemy's self-propelled counterfire capability, SADARM contributes to ***full-dimensional protection***. Denying the enemy's use of self-propelled howitzers better enables friendly forces to move at will and ***dominate maneuver***.

SADARM is designed to attack and kill lightly armored vehicles. Each 155-millimeter howitzer round delivers two submunitions. Once dispensed, the submunition deploys a parachute-like deceleration device. At a predetermined distance from the ground, the submunition ejects the deceleration device and deploys another device to stabilize and rotate the submunition. As the submunition falls and rotates, it searches the ground with millimeter wave sensors (both active and passive) and an infrared sensor array. Using the sensors and detection logic, the submunition is designed to detect countermeasured targets in a

variety of climates. If the sensors detect a target, the submunition fires an explosively formed penetrator at the target. If no target is detected, the submunition is designed to self-destruct.

Basic SADARM has gone through extensive technical and operational testing. Because of problems with submunition reliability, the Army decided to field a limited number (fewer than 1,000) of basic SADARM rounds. SADARM product improvement (PI) potentially increases basic SADARM's effectiveness by increasing the detection area and improving detection algorithms and sensors (at lower altitudes). Additionally, modeling and simulation will be used to improve the basic SADARM design, creating a more reliable submunition. Although the Army considered implementing a multi-explosively formed penetrator warhead in PI SADARM, the only planned changes from the basic SADARM warhead are the substitution of a less sensitive explosive and some adjustments to the warhead liner. A full-rate production decision will be made for PI SADARM in FY05.

BACKGROUND INFORMATION

SADARM entered low-rate production in March 1995. Testing prior to this decision showed poor reliability at the longest range. Technical testing from 1996-1998 showed improvement in submunition reliability at the longest range, but still below the 80 percent reliability requirement. By 1998, reliability at 15 kilometers was 70 percent. In addition, incompatibility between the SADARM round and the electronic fuze was discovered. The Army decided to field basic SADARM with only the mechanical fuze, but the Army will continue to investigate this incompatibility for PI SADARM. There were also a number of critical technical tests at Yuma Proving Ground, AZ, and Ft. Greely, AK, to test SADARM's capabilities in a variety of countermeasures and environments. The weather varied from rain to sun to snow. All of the tactical rounds were fired at 15 kilometers, where submunition reliability was greatest.

IOT&E was conducted in August 1998 at Ft. Greely. The Defense Intelligence Agency validated that target array was similar to the defensive array used in the Ft. Greely technical tests; the technical tests used different countermeasure camouflage nets. All of the target vehicles were actual threat vehicles. All five missions of 24 rounds each (120 total) were fired at 19.4 kilometers. The Army validated this as a likely range for an operational scenario. Besides range, the other major difference between the operational and technical tests was firing procedures and thus accuracy. Soldiers generated the inputs and calculated the ballistic solutions using equipment, software, and methods representative of what would be available when SADARM is fielded. The operational test results were well below requirements.

Major LFT&E activities were completed in FY98. To augment the lethality data from about 30 impacts on a variety of threat vehicles during end-to-end technical test firings, a seven-shot tower test against 2S3 self-propelled howitzers and a T-72 tank were conducted at Aberdeen Proving Ground, MD. The impacts on actual threat targets during the initial operational test provided valid additional data for live fire assessment.

TEST & EVALUATION ACTIVITY

Testing in 1999 focused on improving the submunition reliability at the longest ranges. After finding and fixing failure modes through a series of high stress tests, the contractor conducted a test at 19 kilometers in April and May 1999. Tactical rounds and rounds without warheads (simulants) were fired under a variety of temperature conditions. The contractor scored ten tactical rounds (20 submunitions),

fired at ambient desert conditions as 68 percent (13/19) reliable and eight simulants, four conditioned cold and four conditioned hot, as 38 percent (3/8) and 25 percent (2/8) reliable, respectively. Fixes for failure modes experienced during these firings were incorporated into production rounds for testing in August and September 1999. At that time the government fired tactical rounds at 17 and 19 kilometers at ambient desert temperature. Fifteen rounds fired with the higher powder charge needed to reach longer ranges were scored as 79 percent (23/29) reliable. A reliability of 74 percent (20/27) was scored for fifteen rounds fired with lower powder charges at 17 kilometers. Additional reliability testing (scheduled for January and March 2000) will determine if the contractor can maintain this improved tactical reliability and evaluate the reliability of additional hot and cold conditioned rounds.

DOT&E has actively participated in planning the basic SADARM Limited User Test scheduled in April 2000. The Limited User Test will support the Army's decision to field the limited number of basic SADARM rounds produced. As currently planned, the Limited User Test will be executed in an operationally realistic manner.

DOT&E has been working with the Army to develop a PI SADARM evaluation strategy. The PI SADARM program will combine modeling and simulation with verification testing. In addition, there will be an operational test to support the PI SADARM full-rate production decision. A revised PI SADARM LFT&E Strategy is also under development, with the overall goals to determine the lethality of PI SADARM and compare that lethality to basic SADARM. The requirement for full-up, system-level testing will be accomplished by including threat targets from the evaluation target set in the target arrays for various end-to-end firing events. A tower test similar to basic SADARM will not be required unless sufficient real targets cannot be made available for end-to-end testing to generate the data needed to assess PI SADARM lethality against its expected targets.

TEST & EVALUATION ASSESSMENT

In 1998, DOT&E assessed the system to be not operationally effective and not operationally suitable. Major factors in this assessment were variable submunition performance, winds, and system reliability. Submunition performance varied depending on factors including realistic target emplacement in foliage, countermeasure nets, countermeasure heat sources such as fires or expended shell casings, and time of day. Winds affected submunition delivery accuracy and operational effectiveness during some missions fired. Missions were also cancelled to avoid high wind conditions. Low submunition reliability, 44 percent observed versus 80 percent required, was a significant factor in the overall assessment. Even when known adverse conditions were absent, performance still did not meet the requirement.

There has been some progress in system reliability since the IOT&E. The most recent reliability tests demonstrated reliabilities of 79 percent for rounds fired with the higher power charge necessary to reach 19 kilometers and 74 percent reliability at 17 kilometers. The 19-kilometer reliability is significantly higher that the 44 percent demonstrated in the OT. However, reliability at 17 kilometers is the same as that observed in early 1998. It is not clear what changes have been made to increase reliability at 19 kilometers, but not at 17 kilometers. Tests in January and March 2000 will demonstrate whether the production line can maintain this reliability. Issues of wind and variable submunition performance (major contributors to poor OT performance) will not be addressed by basic SADARM. DOT&E will complete an operational assessment after the April 2000 basic SADARM Limited User Test.

DOT&E's Live Fire lethality assessment of the basic SADARM warhead concludes that it is capable of destroying its expected primary threat targets, given that it strikes its targets. SADARM also has some capability against tank targets, but to a lesser degree.

The Army has attempted to address all the recommendations made in DOT&E's 1998 operational assessment. DOT&E representatives have participated in reliability meetings, a new integrated process team has been formed to discuss and consider options for improving SADARM's operational employment, production verification testing has been included in the TEMP, and additional operational testing (for basic and PI SADARM) is planned.

PI SADARM has the potential to overcome basic SADARM problems highlighted in OT. The use of modeling and simulation in the PI SADARM hardware design has the potential to increase submunition reliability. The contractor is also considering algorithm changes to improve submunition performance. This potential increase in effectiveness can be adequately assessed with the testing and modeling strategy in development between the Army and DOT&E.

LESSONS LEARNED

The basic SADARM program was highly successful in integrating a variety of actual threat vehicles into target arrays for technical tests and the initial operational test. The result was a fivefold increase in the number of data points available to support the live fire evaluation over what would have been available from only the dedicated tower test. This approach will continue for PI SADARM.

The SADARM program demonstrated that technical tests can result in misleading conclusions regarding total system operational performance. Extensive technical testing demonstrated that a reliable SADARM submunition can kill a target if the submunition is placed over the target. One of the major problems in OT, due to winds, was placing the submunitions over the target. At this time, target area winds cannot be estimated by the gun crews 19 kilometers away. Computer modeling before OT underestimated the effects of winds. A failure of the technical testing was to not record or evaluate the wind effects on the submunitions. This failure demonstrated the importance of early operational testing before dedicated IOT&E, to identify and solve operational problems. SADARM technical testing was not realistic enough to meet this need.

The SADARM program demonstrated the importance of considering the production process as part of the submunition configuration. SADARM technical testing demonstrated that reliable submunitions can kill targets in a variety of conditions. However, submunition reliability has been a constant problem, particularly at longer ranges. The failure modes have consistently been linked to production processes rather than design errors.